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THE UNIVERSITY OF ALBERTA

Relationship of Age and Speed of Response to Verbal and Visual-spatial Performance

by

Eda McClung

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A THESIS

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DEGREE OF MASTER OF EDUCATION

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THE UNIVERSITY OF ALBERTA

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled Relationship of Age and Speed of Response to Verbal and Visual-spatial Performance submitted by Eda McClung in partial fulfilment of the requirements for the degree of Master of Education in Counselling Psychology.

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Supervisor

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Date: April 18, 1988.

Abstract

The purpose of this study was to investigate the relationship of age and speed of response to performance on tests of verbal and visual-spatial ability. The hypothesis that age and speed of response interact to produce relatively greater decrements in older individuals on verbal as well as visual-spatial tasks was examined in 40 older females (ages 55 - 74 years) and 40 younger females (ages 20 - 24 years), matched for superiority of education relative to their age counterparts.

Each participant was individually tested with WAIS-R Vocabulary and Block Design, and MAB Vocabulary and Spatial (The MAB is a new group intelligence test designed to parallel the WAIS-R in a timed, multiple choice format). The subtests chosen from the MAB and WAIS-R are among those considered to be the best markers of verbal and performance dimensions of intelligence. Half of the subjects in each age group were tested under standard, timed conditions; the other half were tested untimed and allowed to continue until they had finished.

It was found that age group but not test condition made a significant difference on both vocabulary tests with the older group scoring higher. For the intellectually superior sample, the MAB Vocabulary was deemed too easy to show an age-task interaction as both age groups were able to complete the test within the conventional time limit.

Age effects but no test condition differences were found on WAIS-R Block Design; the younger group had significantly higher scores. Age group and test condition differences but no interaction were found on MAB Spatial. It is suggested that the older subjects, like the younger ones, were of sufficiently high ability to benefit from bonus points for speed or benefit equivalently from the untimed test conditions.

Computation of correlations shows that the MAB / WAIS-R subtests are substantially correlated. Use of differing modalities and task demands (MAB / WAIS-R) may be partly responsible for less than perfect correlation.

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CHAPTER I

INTRODUCTION TO THE STUDY

Introduction to the Problem

One of the most consistent and widely accepted findings in the study of aging is that tests measuring verbal achievement remain relatively constant whereas tests measuring perceptual-integrative abilities, particularly those involving speed, decline with age. This pattern has been evident under a wide variety of circumstances and in differing sample compositions with regard to age, intelligence, education and socio-economic background (Jarvik, 1973). Indeed, Botwinick (1977) labelled it the "classic" aging pattern.

Despite the apparent resolutions of broad issues in this area, some important points regarding the role of speed in tests of ability have not been fully explored. Among the hypotheses advanced to account for the poorer performance by the elderly on perceptual-motor tasks is that it may be attributable to the timed or speeded format of these measures. Verbal abilities on the other hand, which show little decline, are seldom administered under timed conditions. This is the test structure of the widely used Wechsler (1981) scales of intelligence. Measured in this way, the underlying assumption implies that speed of response is more relevant to perceptual-integrative tasks than to verbal-cognitive abilities.

This assumption is contrary to one of the most clearly established and important phenomena of aging, namely that the slowing of behavior with age is significant and ubiquitous (Birren, Wood & Williams, 1980). Research suggests that sensory-motor mechanisms have been judged less important in slowing than CNS mechanisms

underlying the rate at which information can be taken in, processed and retrieved.

The current interest in functional specialization of the two cerebral hemispheres has spawned voluminous research. Although most of this research suggests that simple reaction times are greatly influenced by age, there is no consistent evidence to show that there is a differential hemispheric effect with aging. Stern, Oster and Newport (1980) suggest that these results place limitations on the generalization that the aging process has a more detrimental effect on nonverbal than on verbal processing. They suggest instead that the focus should be on task demands, such as memory or learning, rather than on stimulus characteristics such as verbal or nonverbal.

Different findings may be a function of both the task and task demand. Acknowledgement that all behavior is somewhat speeded is common to both cognitive information processing theories of intellectual ability and psychometric approaches. No tasks completely eliminate time constraints. Therefore the use of unspeeded tasks may not be constructive in the sense that a valid aspect of intellectual behavior may be de-emphasized.

If the same speeded conditions were applied to verbal tests, would the "classical" aging pattern of verbal-performance differences diminish? The idea of vocabulary stability generally continues to enjoy uncritical acceptance, however there are few recent studies that evaluate vocabulary under speeded conditions. Thus the age-related differential decline may in part be an artifact of the techniques used to examine performance. It may be that all abilities decline with age, and that for proper comparison they must be evaluated using the same test conditions.

The majority of investigations into age-related intellectual decline study the role

of speed by removing it as a factor from the performance subtests. It can be argued that this approach can only yield indirect evidence. A preferable approach would be to impose speed as a constant factor across all abilities being measured. In other words, both verbal and performance tasks should be investigated using both timed and untimed conditions.

Research using the Wechsler scales has generally been unable to do this because of practical timing problems on the verbal subtests. The recent Canadian publication, Jackson's (1984) Multidimensional Aptitude Battery (MAB), provides a convenient and standardized format for evaluating response speed. It consists of ten subtests modelled after the Wechsler scales, administered under timed conditions. Jackson accounts for his use of uniformly timed subtests by stating that the "speed of processing information, problem solving and of reacting provides important information about intellectual functioning and is properly incorporated into measures of intellectual abilities" (1984, p. 7). In design of the MAB Jackson recognized that both speed and power are important aspects of intellectual functioning, and included both in varying degrees on the MAB subtests.

Statement of the Problem

The primary purpose of the study is to examine the relationship of age (young and old) and test conditions (timed and untimed) on the performance of both verbal and visual-spatial tasks.

The initial focus will be to determine if there is an overall age effect on a vocabulary task administered under timed and untimed conditions to the young and old subjects. The following questions are addressed:

1. Is the older group significantly different from the younger group in performance on a vocabulary test?
2. Is there a significant difference between timed and untimed vocabulary

performance for the young and old groups?

3. Do test condition (timed versus untimed) and age (young versus old) have a differential effect on vocabulary test performance?

The same questions were directed to the overall age effect on performance of a visual-spatial taskadministered under timed and untimed conditions. The following questions were posed:

1. Is the older group significantly different from the younger group in performance on a task of visual-spatial ability?
2. Does timing significantly change the performance of the young and the old on a task of visual-spatial ability?
3. Is there a differential effect of test condition (timed versus untimed) on the performance of the young and old on visual-spatial ability?

A secondary purpose of the study was to examine the relationship of MAB and WAIS-R results. The structure of the MAB closely corresponds to the widely-used WAIS-R, however its automated administration and scoring may be economical alternatives to individual testing. The finding of significant correlations could suggest that the MAB provides the same or parallel data but in more expedient form.

The experiment used a two-way factorial design, involving Age Group (young versus old subjects) and Test Condition (timed versus untimed testing) on four criterion measures of verbal and visual-spatial ability. Data was based on single-occasion measures of MAB Vocabulary, MAB Spatial, WAIS-R Vocabulary and WAIS-R Block Design. Except for WAIS-R Vocabulary, all tests were administered under timed and untimed conditions.

Definition of Terms

In this study, "verbal ability" was operationalized by use of two vocabulary tests:

1. MAB Vocabulary consists of a 46 item multiple-choice test (five-choice response format) based on recognition of word meanings.
2. WAIS-R Vocabulary consists of a list of 35 words requiring verbalization of a definition.

"Spatial abilities" refers to performance on two tests of visual-spatial ability:

1. MAB Spatial is a 50 item test of five-choice multiple-choice questions requiring visual analysis of figure rotation problems.
2. WAIS-R Block Design is an eight item construction task of two-dimensional designs using red and white blocks.

"Speed of response" refers to the total time required to complete either a verbal or nonverbal task administered under timed conditions.

"Test condition" refers to either "timed" or "untimed" test administration.

1. "Timed" test condition refers to tests administered using the standard timing specifications outlined in the WAIS-R and MAB manuals.
2. "Untimed" test condition indicates that subjects were allowed to continue until they completed all possible items.

"Age group" refers to either young or old subjects.

1. "Young" subjects are those females in the 20-24 year old group.
2. "Old" subjects refers to those females in the 55-74 year old age bracket.

These age groups were selected on the basis of their reported equivalence on the WAIS-R Vocabulary norms, irrespective of ability level.

Delimitations of the Study

The delimitations of this study revolve primarily around sampling characteristics which limit the generalizability of results. All of the subjects were female volunteers of average to above average level of education. The sample of academically-superior subjects is a strong feature in studying age differences. Cunningham (1976) reports that education is more highly correlated with ability performance than age. An attempt was made to match both groups on the basis of their superiority (above average) for their age counterparts. Random sampling of people of increasing age would likely result in samples of decreasing education level.

This study was limited to individuals in two age groups (yound and old), who reported no significant health problems in order to not confound health and aging. It has been suggested that illness rather than age is responsible for a significant degree of intellectual decline (Baltes & Schaie, 1976).

It is acknowledged that subjects as healthy and educated as those participating in this study constitute a minority of people found in the general population. However it may be fair to judge that as both health and education continue to improve in the population, that over time this group will increasingly be more representative.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

This chapter reviews the recent research findings relative to age and speed of response as measured by performance on tasks of verbal and visual-spatial ability. It considers this issue in the context of alternate theoretical approaches as well as differing methods of aging research.

Role of Response Speed

Age and speed of response is an old and young issue. Speed and timing remain a topic of considerable importance for understanding the behavior of the aged and how behavior changes with age. Birren (1974) states that the slowing of behavior with age is ubiquitous. Botwinick (1978) has pointed out that one of the least controversial findings is that behavioral slowing with age does occur.

The history of studies dealing with the effect of aging on response speed have gone through a number of changes. The earlier research construed slowing with age as peripheral in a psychomotor sense. This suggests that it is not thinking that slows but rather physical response initiation time. There is also the view that speed is primarily a performance-related, ability-extraneous variable. In this context, ability to perform tasks rapidly is largely of theoretical interest but it is not considered a critical variable in practical terms.

Botwinick (1978; 1981) is representative of those researchers who consider intellectual speed as important in ability functioning. At the basis of this view is the hypothesis that the CNS is the major contributor to response slowing associated with aging. After extensive research in the area, Birren (1974) proposed an intellectual speed hypothesis. He contends that a fundamental change in behavior with age involves a slowing of the rate at which an organism takes in, processes and retrieves information. He suggests that the aging individual undergoes a slowing of activity in the CNS that in turn impairs all processes in normal functioning. Birren justifies his focus on response speed because it qualifies as an "ecologically valid variable" (Birren, Woods & Williams, 1980).

Birren (1980; 1974), Botwinick (1981), Cunningham (1980) are representative of those who regard response speed as an important aspect of intellectual capacity. Cunningham (Witt & Cunningham, 1979) states that "emphasis on unspeeded variables in some current experimental work may not be constructive in the sense that a crucial and unusually valid aspect of intellectual behavior may be de-emphasized" (p.544). Common to both information processing theory and the psychometric approach is the recognizance that all behavior is speeded. Speed of response, measured either in simple reaction time or more complex response time, could be considered the behavioral index that bridges the two theoretical approaches.

Age-related slowing is a well-recognized phenomenon on perceptual-integrative tasks but the intellectual speed hypothesis encompasses performance underlying verbal tasks as well. Hunt (1978), in studying verbal ability, suggests that although vocabulary directly assesses knowledge of language, it may indirectly assess information processing ability. When given the same exposure to linguistic information, an individual with high information processing abilities will fix more information into longterm memory than an individual with low processing speed.

Witt & Cunningham (1979) tested the hypothesis that a measure of intellectual speed assessed at one point in time would predict intellectual achievement at a later point in time. Longitudinal data for subjects tested at age 20 and then again 28 years later with the highly speeded Relations Factor subtests from the Army Alpha,were found highly predictive of both verbal and numerical achievement in middle age. They felt that these findings supplement and extend the earlier cross-sectional work of Hunt on the role of information processing speed and development of later intellectual abilities.

A number of researchers have similarly investigated the relationship of speed of information processing and general intelligence. Vernon (1983) has demonstrated a positive relationship between the speed of cognitive processing, psychometric ability and subsequent intellectual development. He concluded that those with a larger information base have acquired this as a result of basic information processing capability. Over a period of time, such as the years of formal education, faster cognitive processing may allow more information to be acquired.

Based on their extensive research into intellectual abilities, Botwinick & Storandt (1974) also point to a central role for speed. They conclude that age is associated with decreased speed and decreased scores on paper and pencil tests. They view speed as related to "central intactness" but mainly in regard to the ability to process incoming, sequential information quickly (Botwinick, 1981).

As a result of this increasing evidence for a relationship between age, speed and psychometric ability, the present study put forward hypotheses regarding the performance speed of young and old subjects on tests of verbal and visual-spatial ability.

A review of the literature in the area of response slowing is a challenge since the literature includes studies that differentiate reaction time and response time but the

distinction is underemphasized. Slowing in simple reaction time is one of the most replicated findings in behavioral change with age (Birren, Woods & Williams, 1980). Simple reaction time literature is voluminous and complex, and for the most part, not the focus of this study. Of more interest here is response time, which relates to the performance of more complex, intellectual functions measured by psychometric scores.

Cognitive processing literature emphasizes reaction time as the dependent variable. This is largely due to the preferred characteristics of physical measurement over psychometric measurement which is typically by item score. However, psychometric instruments, such as the WAIS-R, have the advantage of established validity and reliability, and a large normative base for a wide range of test scores. The MAB presents with a similar psychometric format however its speeded subtests are based on the underlying proposition that links intelligent behavior and speed of processing information, problem solving and reacting (Vernon, 1983).

Although there is widespread agreement over the existence of age-related slowing, there is less concensus as to its significance. Gerontological researchers from the life-span developmental perspective (Baltes & Schaie, 1976; Furry & Baltes, 1973; Hoyer, 1974) de-emphasize the role of intellectual speed. They regard it as a performance-related, extrinsic variable that is optional or artificial. They argue that there is a great deal of plasticity in the cognitive functioning of the elderly but that standardized, norm-based tests of intelligence have been designed to measure mainly stability.

Life-span developmental research on aging emphasizes aging as a lifelong process, with statements directed at both average performance (trait) and intraindividual range of performance (plasticity). This group challenges the traditional evidence on aging

by questioning the limited methodologies i.e. cross-sectional or longitudinal, used to gather evidence. Schaie (1977), in a detailed article, presents his argument for quasi-experimental approaches when age is to be treated as the independent variable. Willis & Baltes (1980) propose use of cohort-sequential designs in order to evaluate both inter- and intraindividual change, a "differential aging perspective" (p.260).

The life-span developmentalists also draw attention to the use of age and cohort-appropriate test instruments as well as the need for valid norms for the elderly which would control for brain dysfunction (Price, Fein & Feinberg, 1980).

Others may argue that this life-span model, a multicausal-interactive model of influences on aging again confounds the performance-related but ability-extrinsic debate about response speed. At present, no one model can fully account for age-related slowing however a variety of paradigms could augment a standard test battery so that the nature and maximal extent of any strengths and deficits could be better evaluated.

Methods in Aging Research

Considerable attention in gerontological research has been given to clarifying the relation between various forms of data collection. The method used has had a bearing on the type and amount of age-related decline reported. The older literature, of mainly cross-cultural studies, raised questions but was unequivocal in pointing to age decline in intellectual performance. The newer literature, involving more longitudinal research, pointed to less decline with age, and in instances, even no decline (Botwinick, 1978). However, the importance of the speed of behavior is found to be highly robust across differing methods employed to carry out research on aging.

The general criticism of using cross-sectional methods in age-related research is

that there is typically a confound between age and cohort: age effect may be due to cohort experience. Schaie (Schaie & Labouvie-Vief, 1974) and Baltes (Baltes & Schaie, 1976) believe that much data collected on IQ is flawed because it is collected in a cross-sectional rather than longitudinal manner. They argue that the nature of cohort effects and historical change restrict the data to the culture and generation being studied. They believe that age-related changes, such as those reported by Horn (1978) from cross-sectional data are cohort effects rather than actual age changes.

Longitudinal research, on the other hand, points to less decline of intellectual abilities with age, with change occurring at a later date. This design however confounds age and time of measurement i.e. the effects of the intervening time period between measurement. Horn (1978) challenges the Baltes and Schaie position, claiming that their research model is overoptimistic and oversimplistic. Horn reports dramatic decline with age on fluid abilities whereas crystallized abilities increase in adulthood.

Botwinick (1978) does not believe the controversy will be resolved "not because different data are examined but because the same data are interpreted differently" (p.209). He believes that both methods provide similar information. Differences seen between the two research methods are of degree or magnitude, not type. Longitudinal research tends to reflect lesser decline, starting later in life.

Of interest to this study is Botwinick's (1978) summary review of several longitudinal studies pertaining to initial and subsequent levels of ability. His conclusions are also consistent with a cross-sectional approach. He concludes that high level elderly people are characterized by very high verbal ability relative to other members of their cohort, independent of age. They are characterized by high nonverbal intelligence however only when compared to others of the same age. Low ability people show

decrease in both functions in later life and are low by any comparison.

Krauss (1980), in an excellent article, reviews the problems associated with attempts to control variance in aging research, regardless of methodological design. Variables such as education, health and sex need careful consideration according to the research question involved. Each variable presents different yet complex problems that need to be taken into account.

Aging and Verbal Abilities

Vocabulary level has long been recognized as an excellent guide to the general intellectual performance of intact, well-socialized individuals. There is wide-spread agreement that vocabulary test scores tend to remain stable or even increase throughout the adult life span (Kramer & Jarvik, 1979). This finding is reported from cross-sectional (Botwinick, 1981; Granick & Friedman, 1973; Horn, 1978; Klisz, 1978) as well as longitudinal studies (Jarvik, 1973; Schaie & Strother, 1968).

Vocabulary level is the psychometric index that has been identified as the single best measure of both verbal and general mental ability (Miller, 1980). In clinical populations, the concept of selective impairment relies on vocabulary as the score that is the best assessment of premorbid functioning level. Matarazzo (1972) reports that WAIS vocabulary remains relatively impervious to diffuse or bilateral brain dysfunction.

Of interest to this study is the fact that vocabulary is well-maintained in healthy individuals, particularly those of initially high ability (Blum, Clark & Jarvik, 1973). Botwinick (1978) reviewed both cross-sectional and longitudinal data on aging and concluded that the reported differences between the two methods were quantitative more

than qualitative. In general, vocabulary is considered to be a durable trait regardless of personal or task characteristic.

Although the idea of vocabulary stability generally continues to enjoy uncritical acceptance, there are some studies that question its invulnerability. Botwinick & Storandt (1974) examined this idea by analyzing the responses of young and old subjects on WAIS Vocabulary. They found that the overall scores did not differ significantly between the two groups using the conventional scoring system. However when their responses were re-scored on the basis of six qualitative criteria i.e. an excellent synonym received the highest score, then a decline with age was noted. This suggests that further analyses of both verbal and perceptual tasks may reveal an underlying mechanism that is not test specific. It also raises the possibility that assumptions about intactness or stability of a particular function over the life span may be over-stated.

Some investigators have suggested that verbal IQ maintenance and performance IQ decline on the WAIS, with age, may be an artifact of the technique used to measure performance. The decreased correlations between verbal and performance scores may be attributable to the timed or speeded nature of the performance subtests whereas speed is not considered a factor for verbal abilities. The use of bonus points for speed has interesting implications in the lack of comparable procedures on verbal subtests.

Several studies have investigated the role of speed in intellectual aging by merely removing it as a factor from the WAIS performance subtests (Klodin, 1977; Storandt, 1977). It can be argued that this approach can yield only indirect evidence. Psychometric investigation of the role of speed in verbal abilities has generally not been possible for practical reasons with the introduction of the Wechsler scales.

Early studies which used the Primary Mental Abilities Test (PMA) considered both verbal and nonverbal abilities under equivalent, timed test condition. The five PMA subtests (Verbal Meaning, Verbal Fluency, Number Ability, Space and Reasoning) were all timed. Schaie, Rosenthal & Perlman (1953) administered the PMA to older subjects (between the ages of 53 - 78 years). Tests were given in both the regular manner i.e. with time limits, and in an irregular manner i.e. untimed. They found that the untimed administration tended to exaggerate the deficits of the older subjects on Space and Reasoning. Removing the time limits made for greater age difference as it enabled the younger group to score better.

Schaie & Strother (1968), using the PMA in a cross-sequential design, studied test performance in terms of both age differences and age change. They report that age was negatively related to performance and that all tests showed a decline with age when examined cross-sectionally. However when examined longitudinally, only scores on those tests where speed of performance seemed critical (Reasoning and Fluency) declined with age. Scores on Verbal Meaning, Space and Number Abilities were maintained between ages of 20 and 70 years and on a re-test seven years later. The authors concluded that changes over time within a given individual tended to be much smaller than differences between cohorts on all abilites measured by the PMA.

Publication of the MAB (1984), modelled after the Wechsler scales and normed by calibrating the IQ scores to the WAIS-R provides a convenient format for evaluating response speed relative to both verbal and performance abilities. Jackson's (1984) objective in constructing the MAB was to develop a test with "sufficiently difficult content to challenge the gifted, and one which would reward not only quality of performance but, as well, quantity in a given unit of time" (p.42). He reports two studies that evaluated the effects of varying time limits. By comparing means and standard

deviations for five, seven and ten minute time limits, he concluded that the correlations between the sets of scores indicated that largely correlated processes were being assessed by speeded and nonspeeded MAB testing conditions. On the basis of these findings, a seven minute time limit was chosen as standard for the MAB.

Aging and Visual-spatial Abilities

One of the basic distinctions in psychometric theories of intelligence is between verbal and spatial abilities. Spatial ability, the ability to reason about and manipulate visual forms, appears as a subtest in a number of intelligence scales. One of the most consistent and widely accepted findings in gerontological research is that aging is associated with significant decrements in performance on tests measuring perceptual- or spatial-integrative abilities (Matarazzo, 1972). Verbal abilities, on the other hand, show little or no decline.

Among the reasons advanced to account for this differential decline in abilities with aging is the timed or speeded format of such measures on traditional psychometric tests. More specifically, timed testing may unfairly penalize older persons for whom slowing of response speed is a widely accepted finding (Schaie & Stone, 1982).

The Block Design test was originated by Kohs who offered it as a comprehensive measure of nonverbal intelligence. "The initial enthusiasm of its originator seems fully justified. It is an excellent test of general intelligence" (Matarazzo, 1972, p.212). Block Design was incorporated into the Wechsler scales and is recognized as the best measure of visual-spatial organization on the test. It is considered to reflect general mental ability to the extent that intellectually capable but academically limited persons frequently obtain their highest score on this subtest (Lezak, 1983). Wechsler underlined the importance of speed on this subtest by increasing bonus points from two to three per item on the 1981 WAIS revision.

Several studies have been reported that evaluate the relationship of age, ability and method of administration and scoring of the WAIS. It has been argued that the WAIS differentially handicaps the older test takers by imposing time limits.

To test this idea, Storandt (1977) administered the five timed WAIS performance subtests with and without time limits to young and old subjects matched on Information (untimed) subscores. Timing was manipulated in the study by comparing scoring systems for the WAIS: timed with bonus points for speed (conventional), timed but without bonus points, and untimed. In general, it was found that elimination of bonuses for rapid performance differentially improved the scores of the older adults but did not raise them to the level of the younger subjects. The untimed test was not of special benefit to the old who had higher initial ability.

Overall, Storandt concludes that standard cut-off times on the WAIS are as valid for the old as the young, but warned that the time-dependent nature of the bonus questions can underestimate performance levels of older persons.

Klodin (1976) has also suggested that the age-WAIS scoring relationship may be different for different ability groups. Klodin tested young and old subjects (matched for education and Information level) on two speeded subtests, Block Design and Object Assembly. Both have been shown to be age sensitive. The same three-way scoring comparison as Storandt's (1977) was used. It was found that the magnitude of age differences was reduced with timed scoring however the elderly never reached the high performance levels of the young group. The older subjects benefited more than the young with additional time (untimed) whereas the young were better able to score at peak performance with time limitations (and bonus points). Klodin concludes that only subjects with a higher level of initial ability will benefit from untimed administration.

Extra time alone may not be sufficient to insure improved performance. Disparity between the performance scores of young and old is to some extent reduced when time is not a factor in scoring.

Spatial ability, measured by Block Design on the Wechsler scales, is appraised by the Spatial subtest of the MAB. It is a test involving the recognition of two-dimensional rotated figures, similar to an experimental technique developed by Shepard & Metzler (1971). This procedure requires the subject to decide if two figures are either identical or reflected (mirror images of each other). The figure to be matched is generally presented at a "tilt", rotated rather than upright. A key finding in most studies of mental rotation is that decision time to judge whether the figure is "normal" or "reflected" gets longer as the tilt gets greater.

Research has established that subjects required to identify tilted patterns do so by first rotating them into an upright position. Gaylord & Marsh (1975), using three-dimensional figure drawings, found that the rate of mental rotation of elderly subjects was 84% slower than for young subjects.

Another study by Jacewicz & Hartley (1979) questioned these findings. It is of interest because they tested "college-enrolled elderly" and used simpler, two-dimensional alphabet letters. They found no age differences in rotation rates. However with unfamiliar, lower-case Greek letters, the basic speed of older subjects was slower than of younger subjects.

Cerella, Poon, & Fozard (1981) suggest that the Jacewicz & Hartley findings may be due to the unusually young and active elderly sample used (mean age was 56.5 years). They question how similar they were to their age counterparts more usually tested. They

studied a group of older (60 -70 year old, community dwelling) female subjects, using the simpler, letter-rotation task. They found that response time increased with the greater departure from vertical orientation (the phenomenon that supports "mental rotation") for both young and old subjects. But they also noted that the slope of the line relating orientation to response time was greater for the older group. Their findings suggest that age-decline in mental rotation rates is evident but not perhaps to the extent reported by Gaylord & Marsh. They suggest that failure to replicate Jacewicz & Hartley findings of no age reduction in rotation rates stems not from their use of simpler figures but from the use of younger, more able subjects.

Berg, Hertzog, & Hunt (1982) investigated adult age differences in speed and accuracy of mental rotation tasks using a broader age range and a task of intermediate difficulty. They found significant age differences in the speed of spatial visualization with age differences increasing monotonically across the 20- and 60-year age range. There were no significant age-associated differences in error rates. The mental rotation rates were found to be significantly correlated with performance on a psychometric test of spatial ability but not with performance on a vocabulary test. They suggest that age changes in speed of information processing may contribute to age changes in performance on psychometric tests of spatial ability. Herman & Bruce (1983) found strong evidence for age and sex differences in mental rotation rates, with accuracy rates decreasing with increasing age.

The MAB Spatial subtest closely resembles the mental rotation tasks used in the previously discussed studies. The MAB norms reflect the research findings that speeded spatial performance declines markedly with age. For example, a Spatial subtest raw score of 20 for the 20 - 24 year range is equivalent to a performance IQ = 83. The same raw score for the 55 - 64 year age-group indicates an IQ = 120. A performance decrement is noted across the range of intellectual abilities.

CHAPTER III

METHODOLOGY OF THE STUDY

Introduction

The purpose of the study was to investigate the relationship of age and speed of response to performance on tests of vocabulary and visual-spatial ability. This chapter describes the subjects, instruments, procedure, hypotheses to be tested and the statistical analyses used.

Subjects

Eighty subjects were tested. They consisted of 40 older persons ranging in age from 55 - 74 years, with a mean age of 66.08 years (SD = 5.51), and 40 university students ranging in age from 20 - 24 years with a mean age of 22.08 years (SD = 1.29).

These age groups were selected for study on the basis of WAIS-R norms which indicate equivalent Vocabulary raw score - scale scores for age groups 20 - 24 years and 50 - 74 years across all levels of IQ. All of the subjects were female. They participated in the study on an unpaid and voluntary basis.

The elderly group were recruited from seniors' programs and organizations. They were all independently-living and reported themselves to be in good health. As well, this group had attained and maintained a high degree of intellectual activity as evidenced through their mean number of years of education = 14.2 and mean number of years of employment = 25.9. It seems reasonable to assume that the older subjects were high functioning and were above rather than below normal for corresponding age groups in the population.

The younger adults were university students from a variety of faculties. The mean number of years of education for the younger group was 16.25 years.

Instruments

Subjects were tested individually with the WAIS-R Vocabulary and Block Design, and MAB Vocabulary and Spatial subtests. WAIS-R Vocabulary requires verbalization of word definitions whereas MAB Vocabulary consists of recognition of word meanings in a multiple-choice format. WAIS-R Block Design is a visual constructive task whereas MAB Spatial involves visual analysis of two dimensional rotated figures.

Because the subjects were volunteers, the entire WAIS-R and MAB tests were not administered because of the lengthy time requirements. Subtests were selected that have generally been found to be among the best markers of verbal and performance dimensions of intelligence (Hill, Reddon, & Jackson, 1985). These tasks have had substantial use in research and have recognized utility in analyzing adult cognition. Vocabulary is frequently reported as showing stability with age (Botwinick, 1978), and as being the single best measure of both verbal and general mental ability (Kramer & Jarvik, 1979; Lezak, 1983). Block Design is generally recognized as the best measure of visual-spatial organization in the Wechsler scales (Lezak, 1983; Matarazzo, 1972), and is frequently rated as one of the most age-sensitive measures of perceptual-motor functioning. Jackson acknowledges his use of the Wechsler scales as a model for his own test as they have become "the standard against which other tests of intelligence have been appraised" (1984, p. 5).

Procedure

Half the subjects in each age group were assigned to the timed test condition. The other half were tested under untimed conditions. Assignment of the subjects to experimental conditions was randomized through the use of a table of random numbers. The subjects in both age groups and both test conditions were tested individually. They completed the four subtests, described previously, in one testing session.

Tests given under timed conditions received standard instructions as specified in the WAIS-R and MAB manuals. In the untimed condition, all subjects were allowed to continue for as long as it took to complete the test. WAIS-R Vocabulary was administered to all subjects in the standard, untimed format and scored accordingly.

Tests administered under timed conditions were scored as specified in the testing manuals. However in the untimed group, all correct solutions received credit regardless of the time required to complete them. Standard bonus points were given for rapid solution on Block Design.

Research Hypotheses

In accordance with the review of the literature, the following hypotheses were made:

Hypothesis 1: There would be no significant difference in vocabulary level between young and old groups.

Hypothesis 2: Performance on a vocabulary test would be superior in the untimed condition for both age groups.

Hypothesis 3: No age difference would be found in the untimed condition for verbal abilities but the younger subjects would do better than the older ones in the timed condition.

The same age group and test condition hypotheses were made regarding visual-spatial abilities.

Hypothesis 4: There would be significant differences in visual-spatial abilities between young and old groups.

Hypothesis 5: Performance on a visual-spatial task would be superior in the untimed condition to the timed condition for both age groups.

Hypothesis 6: Test condition would have a differential effect for young and old groups on performance of a test of visual-spatial ability.The younger group would benefit significantly more than the older group in the untimed test condition.

Statistical Analysis

An initial analysis was performed on the demographic characteristics of the subjects, such as age and years of education. A 2 x 2 analysis of variance was used to evaluate main effect of Age Group and Test Condition, and the two-way interaction between age and education. Obviously, there should be main effect for age as the two groups were selected for age differences. Control for the effects of education was sought by attempting to select an educationally homogeneous sample. An attempt was made to match both groups on the basis of their superiority (above average) for their age counterparts.

Then four major analyses of variance were calculated to address the research hypotheses outlined above. Throughout the study, a level of significance of .05 was deemed necessary to reject the null hypothesis. The design of the study involved two independent variables, Age Group and Test Condition, and four dependent variables, WAIS-R Vocabulary and Block Design, and MAB Vocabulary and Spatial. The data were based on single occasion measures taken from each subject. An analysis of variance was performed on each of the above four criterion measures. In order to examine the relationship between MAB/WAIS-R scores, correlations between comparable subtests were computed.

CHAPTER IV

RESULTS OF THE STUDY

Introduction

This chapter presents the results of the statistical analyses performed in order that the questions proposed in Chapter 1 and the hypotheses presented in Chapter 3 could be addressed. Initial consideration is given to descriptive data and the analyses done to evaluate the sample used in the study. This is followed by summary data of subtest scores grouped according to age and test condition. The results of four major analyses of variance address the six research hypotheses. The results of a secondary consideration of the study, the correlation of MAB and WAIS-R, are reported.

Descriptive Statistics

Means and standard deviations for each of the four samples on age and years of education are presented in Table I.

Table I

Age and Education Characteristics of the Samples

	Timed Condition		Untimed Condition	
	Mean	St.Dev.	Mean	St.Dev.
Young Sample				
Age	22.30	1.38	21.85	1.18
Education	16.40	1.67	16.10	1.17
Old Sample				
Age	66.60	5.32	65.55	5.79
Education	14.70	2.32	13.70	3.20

Note. Age and education are in years

In order to discern whether there were any age or education differences between the four samples, an ANOVA was computed using age and education as dependent variables, and with Test Condition and Age Group as grouping variables (An ANOVA was performed rather than t-tests, in order to evaluate main effect for age and test condition as well as the two-way interaction simultaneously).

With respect to age, there were no significant main effects for Test Condition, $F(1,76) = .69$, $p > .40$. This means that the samples (young and old) in each experimental group were equivalent in terms of age. However there was a main effect for Age Group, $F(1,76) = 2379.88$ $p < .0005$. This result shows that age statistically differentiated the two groups. Also, there were no two-way interactions between Age Group and Test Condition, $F(1,76) = .11$, $p > .74$.

With respect to education, an ANOVA was performed in order to evaluate any differences in terms of education between the two samples. There were no statistically significant main effects for Test Condition, $F(1,76) = 1.71$, $p > .19$. For Age Group, there was a significant main effect, $F(1,76) = 17.03$, $p < .0005$. What these results mean is that these subgroups defined by Test Condition were equivalent in terms of education, but subgroups defined in terms of age were different in terms of education. The younger groups had more years of education than the older groups (see Table 4:1). The possible significance of this will be discussed later. However, the two-way interaction between Age Group and Test Condition was not statistically significant, $F(1,76) = .50$, $p > .48$.

Hypothesis Testing and Results of Verbal Performance

Table II presents the mean test scores of the subjects arranged according to Age Group and Test Condition. Analyses were conducted on this data to test the six hypotheses outlined in Chapter III.

Table II

Performance by Age Group and Test Conditon

		Timed	Untimed
		WAIS-R Vocab.	WAIS-R Vocab.
		57.00 (6.14)	54.10 (8.71)
	Verbal		
		MAB-V.	MAB-V.
		30.75 (7.77)	30.85 (6.56)
Young			
		WAIS-R B.D.	WAIS-R B.D.
		40.1 (7.89)	40.00 (3.46)
	Spatial		
		MAB Sp.	MAB Sp.
		23.75 (6.59)	47.15 (3.25)
		WAIS-R Vocab.	WAIS-R Vocab.
		61.25 (3.86)	58.55 (6.30)
	Verbal		
		MAB-V.	MAB-V.
		39.40 (5.82)	36.80 (5.75)
Old			
		WAIS-R B.D.	WAIS-R B.D.
		29.40 (8.22)	32.90 (8.87)
	Spatial		
		MAB Sp.	MAB Sp.
		19.15 (6.83)	42.15 (8.08)

Note. * Scores reported as mean raw scores with standard deviations in brackets.

Hypothesis 1: An analysis of variance was carried out on WAIS-R Vocabulary to test for vocabulary equivalence between young and old subjects. The results, as reported in Table III do not support the hypothesis that there would be no significant age differences.

Table III

Summary of ANOVA: WAIS-R Vocabulary by Test Condition and Age Group

Source	SS	F	p
Test Condition	156.80	3.73	0.06
Age Group	378.45	9.01	0.004 *
Test Condition x Age Group	0.20	0.005	0.945

Note. * differences significant at .05 level or less

These results show a significant relationship between age and vocabulary level. As seen in Table 4:2, the WAIS-R Vocabulary scores in the older group i.e. 61.25 and 58.55, are consistently higher than in the young group i.e. 57.00 and 54.10.

Hypothesis 2: To test the hypothesis that performance on an untimed vocabulary test would be superior for both age groups, an analysis of variance was carried out on an MAB Vocabulary between timed and untimed test conditions (see Table IV).

Table IV

Summary of ANOVA: MAB Vocabulary by Test Condition and Age Group

Source	SS	F	p
Test Condition	31.25	0.734	0.394
Age Group	1065.80	25.044	0.000 *
Test Condition x Age Group	36.45	0.857	0.358

Note. * differences significant at .05 level or less

The analysis failed to confirm the above hypothesis. Test Conditions did not make a difference ($p>.05$) for either age group. It should be noted however that an administration of the MAB Vocabulary (timed), the 7-minute time period specified in the manual was sufficient for most subjects to complete the test. Administratively therefore, the timing limitations did not affect either age group. Although the subtest is considered "timed", it was not highly "speeded" for those individuals in this study.

In view of the fact that speed of verbal response did not apply to measurement of MAB - Vocabulary performance, the results could be considered in terms of the first hypothesis, namely the equivalence of vocabulary between young and old groups. Again,

the results (see Table IV) indicate that a significant age difference exists for vocabulary in favour of the older group. Table II shows that the older group obtained MAB - Vocabulary scores of 39.4 and 36.8 on the timed and untimed conditions respectively, whereas the young group show consistently lower scores of 30.75 and 30.85.

It is of interest that the young subjects in this sample have more education (see Table I) yet the older group scored higher on both expressive and recognition type of vocabulary. It is generally accepted that level of education and verbal achievement scores are correlated. Therefore, additional analyses of performance between yound and old groups will be considered in Chapter V, using both level of education and vocabulary scores as covariates.

Hypothesis 3: The results of the analysis of variance reported in Table IV do not support the hypothesis that the magnitude of improvement under untimed test conditions would be different for young and old groups on a test of vocabulary. As discussed earlier, failure to confirm this hypothesis for an age-related differential may be due to the above average subjects in this study who were able to finish a "timed" vocabulary test.

Hypothesis Testing and Results of Visual-spatial Performance

The following results were obtained from ANOVAs carried out on the data reported in Table II pertaining to the relationship of age and test condition to visual-spatial abilities.

Hypothesis 4: Two analyses of variance were performed to test the hypotheses that young and old groups show significant differences on tests of visual-spatial ability.

An analysis of variance for WAIS-R Block Design between young and old groups (see Table V) indicated a significant Age Group difference. Table II shows that the age differences were in the predicted direction, namely that the older group was unable to perform at the level of the younger group. As well as obtaining lower mean scores, the variance of the older group was greater. This statistic is consistent with reported findings (Cunningham, 1980) of greater variance with age, particularly on speeded tasks.

Table V

Summary of ANOVA: WAIS-R Block Design by Test Condition and Age Group

Source	SS	F	p
Test Condition	57.80	1.049	0.31
Age Group	1584.20	28.746	0.000 *
Test Condition by Age Group	64.80	1.176	0.28

Note. * differences significant at .05 level or less

The above hypothesis was tested a second time by carrying out an analysis of variance on MAB-Spatial between young and old groups. As the results in Table VI indicate, there is a significant main effect again for Age Group, as hypothesized.

Table VI

Summary of ANOVA: MAB Spatial by Test Condition and Age Group

Source	SS	F	p
Test Condition	10764.80	259.442	0.000 *
Age Group	460.80	11.106	0.001 *
Test Condition x Age Group	0.80	0.019	0.890

Note. * differences significant at .05 level or less

These results show that despite unlimited time, the scores of the older group did not reach the level of the younger group (see Table II). As well, the variability of performance was larger in the older subjects.

Hypothesis 5: The results of analyses of variance, reported in Tables V and VI, indicate a significant difference in visual-spatial performance between timed and untimed test condition on MAB-Spatial. However, no significant difference was found between timed and unitmed test conditions on WAIS-R Block Design. Table II shows that for the young group, their scores on timed or untimed testing of WAIS-R Block Design were virtually

identical. For the older group, the additional time improved their scores, but not significantly.

A different result was obtained using the MAB-Spatial test. Table VI shows that a highly significant difference occurred in performance between timed or untimed test condition. Table II shows that the difference was in the anticipated direction, i.e. both groups improved their scores significantly when tested without time limits.

Hypothesis 6: Tables V and VI reveal that there was no significant interaction between Test Condition and Age Group on either WAIS-R Block Design or MAB-Spatial. This means that additional time did not differentially benefit either age group. For instance, on MAB-Spatial, both groups improved their performance during untimed testing, however the magnitude of their improvement was virtually identical, i.e. 23 points for the older group compared to 23.4 for the younger group.

Correlations Between the MAB and the WAIS-R

A secondary purpose of the study was to examine the relationship between the scores of the MAB and the WAIS-R. The two MAB subtests used, Vocabulary and Spatial, have counterparts on the WAIS-R, namely Vocabulary and Block Design. Product-moment correlations between comparable subtests were computed. Five sets of Pearson correlation coefficients are presented in Table VII, comparing MAB / WAIS-R by age group, test condition and full sample. The p-values are for one-tailed significance tests of the correlations (one-tailed tests were used because it was expected that the correlations would be positive).

Table VII shows the correlation coefficients between the WAIS-R and MAB based on the results of this study. Correlations for the verbal subtests are (.75) somewhat lower than those found by Jackson (.89). These differences may be due to the use of

Table VII

Correlations Between the MAB and WAIS-R

	Age Group / Test Condition				
	Young Timed (N=20)	Young Untimed (N=20)	Old Timed (N=20)	Old Untimed (N=20)	Full Sample (N=80)
Subtests					
Vocab./Vocab.	.78 *	.82 *	.54 *	.70 *	.75 *
p-value	.000	.000	.007	.000	.000
Spatial/B.D.	.58 *	(.22)	.59 *	(.85) *	.44 *
p-value	.004	.176	.003	.000	.000

Notes. * indicates correlations are significantly greater than 0

Correlations reported in MAB Manual (1984):

.89 Vocabulary/Vocabulary,

.44 Spatial/Block Design

( ) denotes nonstandardized administration

select, high-functioning subjects in this test sample, which attenuated the variances which in turn lowered the correlations.

The correlation of Spatial/Block Design for Full Sample is identical with that reported by Jackson (.44). This statistic is somewhat misleading because it includes those groups which did not take the tests under standard, timed conditions. Therefore, the remaining, standardized scores actually show higher and uniform correlations (.58 and .59) for young and old groups.

CHAPTER V

SUMMARY, DISCUSSION AND RECOMMENDATIONS

Introduction

This chapter summarizes the results of the study and discuss some practical implications based on the investigative findings. Suggestions for further research will also be considered.

Summary of the Study

The purpose of this study was to investigate the relationship of age and speed of response to performance on tests of vocabulary and visual-spatial ability. The subtests used to measure the Age Group/Test Condition relationship were selected from the MAB and WAIS-R. They are among those subtests considered to be the best markers of verbal and performance dimensions of intelligence. The WAIS-R has been the most widely used, standardized measure of adult intelligence; the MAB is a recently published Canadian test designed to parallel the WAIS-R in a multiple choice format.

The major difference between the MAB and WAIS-R is in design. The MAB is a group test capable of automated administration, scoring and interpretation; the WAIS-R is an individually administered test. Therefore, a secondary purpose of the study was to compare the relationship of MAB and WAIS-R results to determine to what extent the MAB may be an economical alternative to individual testing.

A total of 80 subjects, divided into young and old age groups, were administered the WAIS-R Vocabulary and Block Design subtests, and the MAB Vocabulary and Spatial subtests. Half of the subjects in each age group were timed according to standard

test instructions. The other half were permitted to continue until they had finished. Although the subjects were from contrasting age groups, an attempt was made to match them for superiority of education for their age counterparts.

Six hypotheses regarding the Age Group/Test Condition relationship were addressed. Hypotheses regarding verbal abilities were as follows:

Hypothesis 1: There would be no significant age group differences in vocabulary level.

Hypothesis 2: There would be significant test condition differences. Performance on the untimed condition would be superior for both age groups.

Hypothesis 3: No age differences would be found in the untimed condition but the younger subjects would score higher than the older subjects in the timed condition.

Hypotheses regarding visual-spatial performance were as follows:

Hypothesis 4: There would be significant age differences in visual-spatial abilities. The young group will score higher than the old group.

Hypothesis 5: There would also be significant test condition differences. Performance on the untimed condition would be superior for both age groups.

Hypothesis 6: Test condition will have a differential effect for young and old groups. The younger group will benefit significantly more than the older group in

the untimed test condition.

A preliminary analysis was performed to discern whether there were significant age or education differences between the four samples. The samples (young and old) in each experimental group were equivalent in terms of age. With respect to education, the subgroups defined by Test Condition were equivalent but subgroups defined by age were different. The younger groups had more years of education than the older groups.

An ANOVA performed on the test scores show that the three hypotheses addressing verbal abilities were not confirmed:

Hypothesis 1: Significant age group differences were found in terms of vocabulary level. The older subjects scored significantly higher than the younger ones. This performance difference was evident on both an expressive vocabulary measure such as the WAIS-R as well as a more objectively-scorable, recognition vocabulary test such as the MAB.

Hypothesis 2: No significant test condition differences were found on vocabulary performance. Test scores obtained from timed and untimed test conditions did not differ significantly for either age group. This may be due to a ceiling effect as most subjects were able to finish the MAB Vocabulary within the specified time allotment. Therefore administratively, the test may be viewed as timed but not highly speeded.

Hypothesis 3: No significant interaction was found between Age Group and Test Condition. The lack of significant findings may be the result of a ceiling effect preventing the assessment of vocabulary under truly speeded conditions.

The results of the statistical analyses of visual- spatial test scores show that two of the

three hypotheses proposed were confirmed:

Hypothesis 4: Significant age group differences were found in terms of visual-spatial performance. These age differences were in the predicted direction, namely that the performance of the young group was superior to that of the older group.

Hypothesis 5: Significant test condition differences were found on MAB Spatial but not on WAIS-R Block design. The difference between timed and untimed MAB Spatial scores was in the expected direction, namely that the timing of the test negatively affected overall performance for both age groups. The main effect of Test Condition here was highly significant in that both age groups showed marked improvement in their scores during untimed testing.

On WAIS-R Block design, there was essentially no score difference for the young group between timed and untimed testing (raw scores of 40.1 and 40.0 respectively). For the older group, although there was a 3.5 point mean score difference between timed and untimed testing, the difference between means was not significant ($p < .112$). It is therefore concluded that the two test conditions were not exerting a differential effect on the performance of the contrasting age groups.

Hypothesis 6: Although significant age group differences were found on visual-spatial performance, and although test condition made a highly significant difference in overall MAB Spatial performance, no significant Age Group by Test Condition interaction was found. The additional time in the untimed condition benefited both groups equivalently.

Discussion of the Results

Additional Data Analyses: In view of the finding that the two age groups differed

with respect to both years of education and vocabulary level, additional analyses were performed to evaluate possible confounding effects of these two variables.

One of the distinguishing aspects of this study was the superior level of education of the subjects. Although an attempt was made to match the young and old groups for general superiority of education, analyses revealed that the two groups differed in actual years of education. The significance of this statistic presents some interpretative problems because no completely reliable standards exist for assigning levels of education. For example, it is unclear whether actual years of education or highest level attained would be the more appropriate index. As well, it is unknown whether years of education is a variable with identical meaning across generations. Years of education may not be a completely adequate measure of an individual's level of education.

A re-analysis of the data was done by performing an analysis of covariance using years of education as the covariate. This was done to control for possible confounding effects of education on overall ability performance. The re-analysis shows that the results obtained using ANOVA and ANCOVA are virtually identical. The use of education as a covariate did not change the results or conclusions because the covariate was not statistically significant.

For example, looking at the MAB Vocabulary score with education as a covariate shows that the covariate is not significant ($F=.02$; $p>.89$). Although on WAIS-R Block Design the covariate was significant ($F=7.23$; $p>.009$) yet the results with the covariate are interpretatively identical with those of ANOVA: there was main effect for Age Group but not Test Condition and no interaction. It was therefore concluded that differences in years of education did not effect the previously reported results.

In view of the significant differences on vocabulary level between the young and old groups, two ANCOVAs were done using MAB Vocabulary and WAIS-R Vocabulary as covariates. This was deemed worthwhile in view of the general importance ascribed to vocabulary as a single best measure of both verbal and general mental ability. By covarying vocabulary it is possible to control for possible differences in overall verbal ability level between the two age groups. In a sense, vocabulary may be a more reliable variable than education because it is a good index of achievement.

Although the two vocabulary tests correlated significantly with each other, the remaining analyses using ANCOVA produced results that are interpretatively identical with those reported in Chapter IV. These essentially are that Age Group had a significant effect on performance of verbal and visual-spatial tasks, Test Condition made no significant difference and there was no Age Group by Test Condition interaction.

Discussion of Verbal Performance: The finding of differences in vocabulary levels of young and old subjects in this study is not consistent with the norms provided by the widely-used WAIS-R. However, there is research evidence that the classical aging pattern in intact older persons is maintenance or even increase in verbal scores, particularly Vocabulary and Information (Botwinick, 1981; Kramer & Jarvik, 1979). The sample of older subjects in this study represents the exceptionally healthy, educated and active segment of the aging population. It is consistent with the view of crystallized intelligence (Horn & Donaldsen, 1976) that verbal ability increases throughout the life span because it is based on the cumulation of learning and personal experience. The sample of university students was mainly from science-based faculties where perhaps nonverbal reasoning ability is more developed than verbal-expressive skills. The sex of the sample, in this case female, is not considered a significant factor. Botwinick (1978) found that WAIS Vocabulary when scored conventionally did not depend substantially on

sex, health or central intactness.

The role of response speed in verbal performance, in either young or old subjects, was not determined. In order to properly compare the WAIS-R and MAB, it was necessary to administer the subtests according to standard instructions. In doing this however, a ceiling effect was found on MAB Vocabulary. It appears for this group, the task was too easy to show an age-task interaction. It is possible that for a lower functioning group of subjects the subtest could be a combination of speed and ability. Jackson acknowledges the need for a "proper balance between speed and power" (1984, p.43) and says that both are represented in varying degrees on all of the MAB subtests. The present findings suggest that for individuals of above average verbal ability, the test depends more significantly on the power of their vocabulary than on the speed of their response.

Discussion of Visual-Spatial Performance: The findings of this study showing age-differences in visual-spatial functioning is consistent with a vast and well established research literature. Klisz (1978) re-examined Reitan's work and found that the best discrimination between young and old groups was obtained by right hemisphere tests (e.g.) Block Design.

A similar age-difference score on MAB-Spatial is generally supported by the complex research findings into the relationship of age-related slowing and ability for rotation of mental images (Berg, 1982; Cerella, Poon, & Fozard, 1981; Jacewicz & Hartley, 1979). In addition to a decrease in rate of mental rotation with increasing age, the present study found age-related decreases in accuracy of rotation on MAB Spatial (timed). In comparing the proportion of correct items to the total number of items

attempted, the young adults were significantly more accurate than the older group (84.4% versus 70.2%). This was a significant difference between the two groups ($t = 3.28$, $df = 38$, $p < 0.01$). This finding is consistent with those reported by Bruce & Herman (1983) and Gaylord & Marsh (1975).

The failure to find age-related slowing on Block Design may be because of the rather select sample of older subjects. Their functioning pattern was consistent with that of the younger group, i.e. the older subjects were not significantly aided by the untimed condition. Klodin (1976) and Storandt (1977) investigated the relationship of scoring and age on the WAIS. They found that older subjects benefited most from untimed administration and the young from bonus points for speed. However they suggested that the age-WAIS scoring relationship may be different for different ability-level groups. The findings of this study showing that untimed testing was not of special benefit to the older group may be because of their relatively high initial ability. This enabled them to benefit from bonus points for speed, similar to the young group. Schwartzman et al. (1987) reports that gains in untimed testing are associated with educational status rather than current age.

Results of testing with MAB Spatial were highly significant for both age and speed of performance. These results are consistent with a vast body of research that reports significant age-related decline in mental rotation rates (Berg, Hertzog & Hunt, 1982; Cerella, Poon & Fozard, 1981; Herman & Bruce, 1983). The failure to find an Age by Test Condition interaction may be due to several factors. Again, the older subjects represent a rather superior segment of the aging population. It is of note that they were able to improve their score by the same magnitude as the young group in untimed conditions. A study by Jacewicz and Hartley (1979), using college students and college-enrolled elderly, found no age by speed differences in such a select sample.

Differences in previously reported results may also be due to the differing sex of the samples. Basic ability for visual-spatial manipulation is reported to show strong sex differences, i.e. men do better than women (Berg, Hertzog, & Hunt, 1982; Herman & Bruce, 1983). The use of a female-only sample in this study would rule out sex-based differences in basic ability which might influence interpretation of scores relative to aging. Evidence for a differential aging process affecting men and women is generally not consistent with the gerontological literature (Botwinick, 1977; Welford, 1977). Norms for psychometric measures, such as the widely used WAIS-R, do not acknowledge any sex differences in intellectual performance or for age effects.

Discussion of WAIS-R and MAB Correlations:

A major source of validity for the MAB is its reportedly favourable correlation with the WAIS-R: Full Scale MAB/WAIS-R correlation is .91 (Jackson, 1984). In comparing the present results with subtest intercorrelations provided by Jackson, similar results were obtained even though the sample in this study was intellectually superior to the norming population.

It is difficult to evaluate the statistical significance of the MAB/WAIS-R correlations for the older subjects. The correlations reported in the MAB manual appear based on a sample size of 145, ranging in age from 16 - 35 years. The two reported validity/reliability studies as well focus on a younger population, in one case, 515 adolescents and the other, 52 young psychiatric patients. With such limited age-groups for reference, the comparability of the present scores for the 55 - 74 year age group is largely undetermined.

A study by Hirsch (1986), using 40 adult students in an educational upgrading program, found a WAIS-R/MAB Vocabulary correlation of .81 which is higher than that

found in the present study. Ackerman (1986), using 40 adults from a counselling centre, found both Vocabulary correlations (.74) and Spatial/Block Design correlations (.63) which were virtually identical with those of the present study. The similarity of these results is of interest in that both studies used a sample that was of above average intelligence.

It is of practical interest to look at the results of the study in terms of IQ, not just raw scores. By doing so, it provides a familiar reference point for evaluating the ability and performance levels of the subjects as well as the relative levels of the young and old groups.

On the WAIS-R, using the age-scaled scores, both young and old obtained a scaled score = 14 on Vocabulary. This indicates that relative to the subjects' age-peers, they were in the above average range (91 percentile). On Block Design, the young group obtained an age scaled score = 12 (75 percentile) whereas the older group had scaled scores ranging from 12 - 14 (75 - 91 percentile). The spread in scores for the older group is based on the wider age range (ages 55 - 74 years). Again, this denotes above average performance for both age groups with no significant verbal/ nonverbal discrepancy.

When the raw scores are converted to IQs, reflecting age-corrected performance, there are some interesting findings. Table VIII compares the MAB and WAIS-R in terms of IQ's obtained.

Table VIII

IQ Scores for Test and Age Group *

	MAB		WAIS-R	
	Young	Old	Young	Old
Vocabulary	122	138	114	124 - 126
Spatial/B.D.	91	130 - 135	114	115 - 122

*Note.** scores calculated from standard test conditions

On the verbal subtests, the MAB reports scores relatively higher than the WAIS-R for both age groups; both score in the superior range. The lower WAIS-R Vocabulary score may be a function of the differing demands of the task, i.e. expressive versus recognition vocabulary. As well, MAB-Vocabulary, prorated to a verbal IQ, may be an overestimation of general verbal ability. Interpretatively however, the two vocabulary scores are broadly similar.

Comparing WAIS-R and MAB results on the visual-spatial subtests, marked differences are noted. The young obtained only marginally average scores on MAB

Spatial (IQ = 91) whereas their nonverbal functioning on the WAIS-R was above average (IQ = 114). A similar score discrepancy was not found for the older group. Since the young scored above average on the other three subtests used, it is difficult to explain their low MAB Spatial performance. If anything, the task characteristics would make it a more suitable test for a student population.

Comparing overall performance of the young and old, using age-appropriate norms not raw scores, the superiority of the older group is obvious. This is evident on both verbal and nonverbal measures, and on individual and group tests. It must be concluded that relative to their age-peers, they were among those considered to represent "successful aging" (Albert, Duffy, & Naeser, 1987, p.155). The data also point to the link reported between continued level of cognitive activity, educational attainment and performance on traditional measures of intelligence regardless of age.

In conclusion, it is possible that the present design was not sensitive enough to detect age differences. Ceiling effects on vocabulary would have been eliminated had individual response time rather than test score been the criterion for evaluating relative response speeds of the two age groups. In other words, the speed of performance would have been a more sensitive measure than number correct score.

It is also possible that the older subjects were simply not old enough to show performance deficits. With regard to longitudinal age changes, no significant decrement in performance is noted before the late 60s (Willis & Baltes, 1986). Regardless of approach, the research literature suggests the relatively late and limited occurrence of age-determined decrement in such healthy, well-educated, active population groups as represented in this study.

Suggestions for Further Research

In terms of further research, the present study suggests that:

1. a larger sample of adult subjects drawn randomly from the general population needs to be studied to determine to what extent the findings of this study of select, high functioning volunteer adults can be generalized. It is acknowledged that volunteer subjects are apt to represent those who are among the more active, capable and intact among their age group.

2. a broader age range of subjects be used, including multiple age groups covering middle age range.

3. the absolute level of performance be assessed by addition of response time measures to supplement 'correct test score' data, in order to differentiate the relative level of performance of contrasting age groups and to remove the possibility of ceiling effects.

4. more extensive sampling of abilities through use of tests that depend more significantly on speed of information processing such as verbal analogies, word fluency and verbal memory.

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